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## A BOTANICAL TRIP TO MEXICO. I.

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**D**URING the summer of 1910 the writer made a trip to Mexico for the purpose of investigating the forage conditions and collecting specimens of the grasses. He was accompanied by his son, Frank H. Hitchcock, as assistant. The technical report upon the grasses has already been published.<sup>1</sup> A brief statement of the topography and climate of Mexico and a record of some general botanical and agricultural observations were also prepared but were never published. The following account is adapted from that manuscript.

## GENERAL REMARKS

In its general aspects the character of the flora of a country depends chiefly on the climate, and this in turn is greatly influenced by the topography. It is therefore advisable to outline briefly the topographic and climatic features of Mexico.

*Topography.*—The portion of Mexico lying north of the

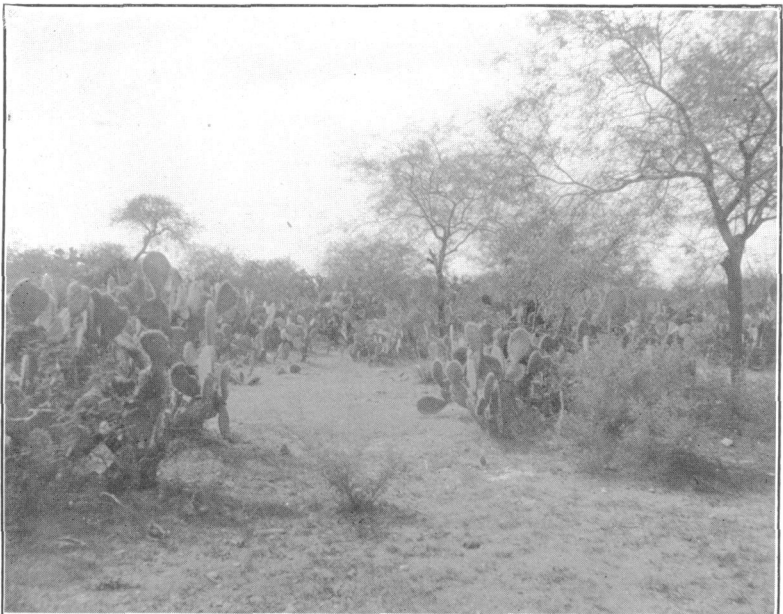


MAP SHOWING THE APPROXIMATE LOCATION OF THE 500-METER INTERVAL CONTOUR LINES. The 1,500-meter line outlines roughly the plateau region which culminates in the vicinity of Mexico City where there is a considerable area above the 2,500-meter line.

<sup>1</sup> Mexican Grasses in the U. S. National Herbarium. Contr. U. S. Nat. Herb. 17: 181-389. 1913.

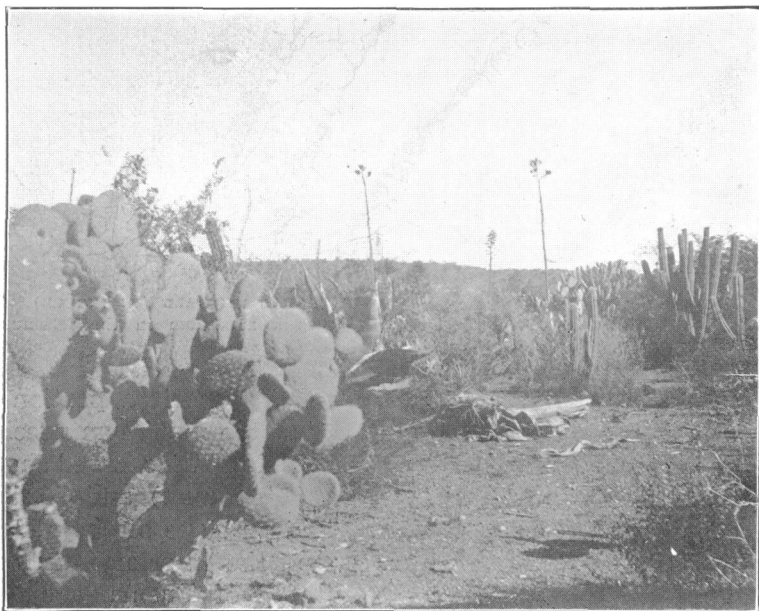


THE MAXIMILIAN CHAPEL IN THE OUTSKIRTS OF QUERÉTARO. Erected by order of the Austrian Government in 1901 to mark the spot where Archduke Maximilian was executed in 1867.



A DESERT SCENE NEAR AGUASCALIENTES.

Isthmus of Tehuantepec consists of a plateau, mostly 3,000 to 8,000 feet in altitude, with a strip of low land along each coast. Upon the plateau are numerous mountain ranges and mountain peaks rising above the general level. The most important range is the Sierra Madre, a continuation of the Rocky Mountain system of the United States. Certain peaks rise to a considerable height, and form conspicuous landmarks over a wide area. Among these may be mentioned Orizaba (18,225 ft.<sup>2</sup>),



A DESERT SCENE NEAR TEHUACÁN, SOUTH OF PUERLA. Cactuses, agaves and thorny shrubs abound, giving the region an aspect similar to that of southern Arizona.

Popocatepetl (17,782 ft.), Ixtaccihuatl (16,060 ft.), all lying along the eastern edge of the plateau and capped by perpetual snow, Toluca (14,900 ft.) and Nevada de Colima (14,370 ft.) in the states of the same names. The strip of low land along the Atlantic coast varies from about 25 miles wide in parts of the state of Veracruz to over 100 miles wide in the state of Tamaulipas. On the Pacific coast the coastal plain is narrow except toward the north where it widens in Sonora to about 100 miles. The coastal region up to about 1,500 feet altitude is known as the *tierra caliente* or hot country, though the region up to about 3,000 feet, in the southern part, has essentially a tropical climate. On the east side the low country near the coast is dryer than the eastern slope of the plateau.

<sup>2</sup> The altitudes are taken from Terry's "Mexico," p. cxxvi, 1909.



MAP SHOWING THE DISTRIBUTION OF THE ANNUAL RAINFALL (IN INCHES). The rainfall increases toward the south and reaches a maximum in the Isthmus of Tehuantepec. Yucatan is drier.

*Climate.*—The winds from the Gulf deposit a portion of their moisture on the coastal plain but the maximum precipitation is reached only in the cooler altitudes. This is well shown by the annual rainfall of Veracruz (1,725 mm.) and Córdoba (2,867 mm.). After passing the eastern slope of the plateau the winds are comparatively dry and the interior is in consequence an arid region. The rainfall of Puebla, about 80 miles west of Córdoba, is only 923 mm. A similar but more striking contrast is shown by the conditions upon the eastern and western slope of Mt. Orizaba, though the rainfall data are not available.

*Rainfall.*—The northern portion of Mexico is arid, the annual rainfall being less than ten inches (25 mm.) The precipitation increases southward and reaches its maximum in the southern part of the state of Veracruz and in the coastal portion of Chiapas. The accompanying map shows approximately the distribution of the annual rainfall.<sup>3</sup>

Over most of the plateau region the rainy season lies in the months from May or June to September or October.

Hann<sup>4</sup> gives a table showing the average annual rainfall in

<sup>3</sup> "Distribution de las lluvias en la Republica mexicana," Carta formada por el Twg. Geographo Guillermo B. y Puga. At the Weather Bureau, Washington, D. C.

<sup>4</sup> Hann, Julius, "Handbuch der Klimatologie," 2: 324. 1910. Another source of information on the rainfall of Mexico is *Memorias de la Sociedad Científica "Antonio Alzate,"* Vol. 16, 1901.

millimeters by months for several stations in Mexico. From Hann's table have been selected the following representative stations:

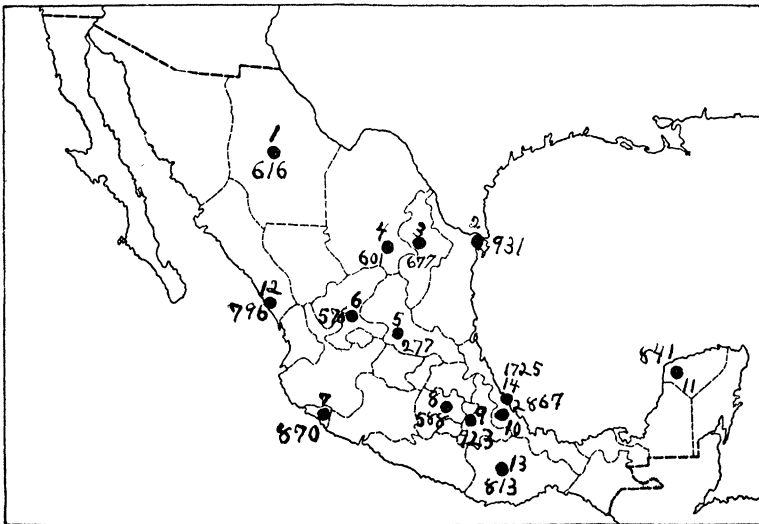
TABLE I

## ANNUAL RAINFALL OF REPRESENTATIVE STATIONS IN MEXICO

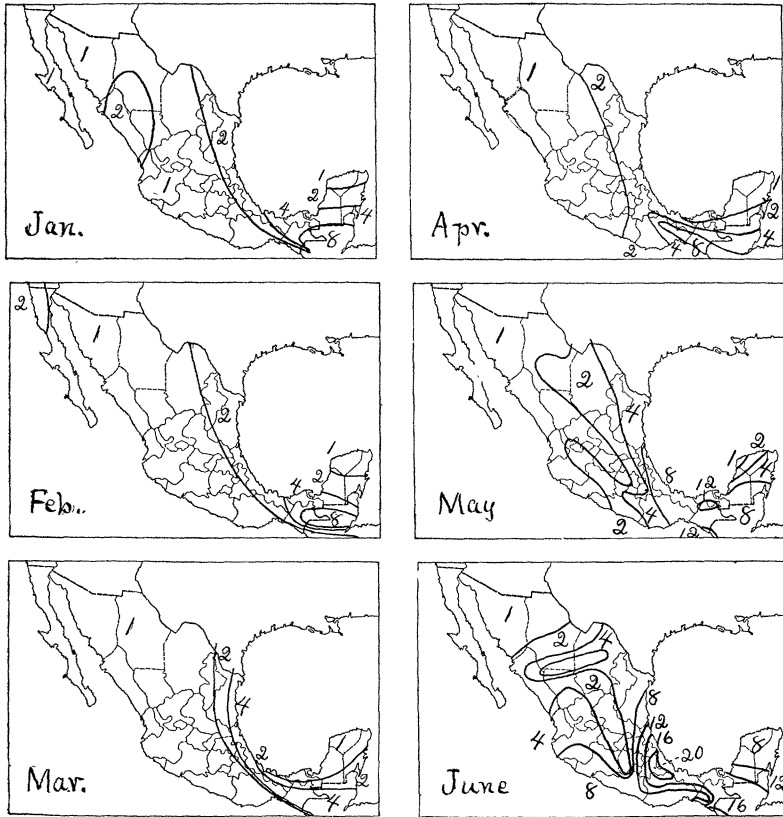
Station.	Annual Rainfall	
	Millimeters.	Inches (approximate).
1. Chihuahua .....	616	24
2. Matamoros .....	931	37
3. Monterey .....	677	26
4. Saltillo .....	601	24
5. San Luis Potosí .....	277	11
6. Zacatecas .....	578	23
7. Colima .....	870	35
8. Mexico City .....	588	23
9. Puebla .....	923	37
10. Córdoba .....	2867	114
11. Mérida .....	841	33
12. Mazatlán .....	796	32
13. Oaxaca .....	813	32
14. Veracruz .....	1725	69

The accompanying map shows the location of these stations.

Hann's table gives the monthly rainfall for nineteen stations. In all cases there is a marked increase for the months of summer and autumn over those of winter and spring. At Chihuahua, in northwestern Mexico, two thirds of the precipitation occurs in July, August and September. At Zacatecas, further south on the plateau, nearly half the precipitation is in June and July. At Mexico City 428 out of a total of 588



MAP SHOWING THE ANNUAL RAINFALL (IN MILLIMETERS) FOR SEVERAL STATIONS IN MEXICO. The figures refer to Table I.



MAP SHOWING THE ANNUAL RAINFALL BY MONTHS.

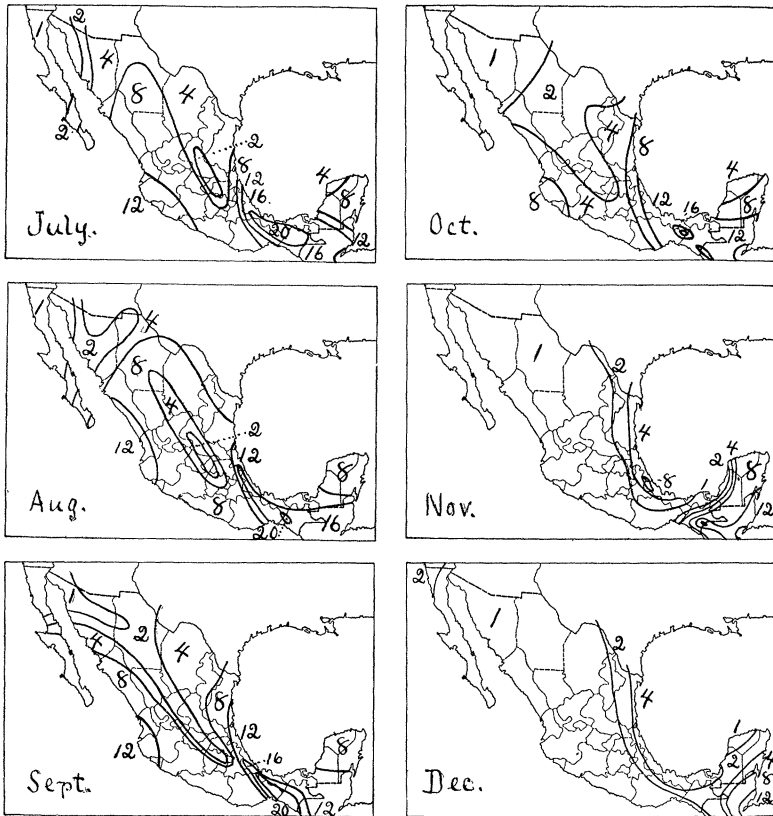
millimeters come from June to September. At Veracruz, on the Gulf Coast, there is a precipitation of 1,550 millimeters from May to October and only 175 millimeters for the other six months. The distribution of the rainfall by months is shown graphically by the following maps.<sup>5</sup>

*Temperature.*—As indicated in the preceding paragraphs the average temperature is dependent largely upon altitude. The seasonal variation is comparatively small except for the northern cities, Matamoros and Monterey.

Hann<sup>6</sup> gives a table showing the average monthly temperature, centigrade, for several stations in Mexico. No records are given for the northwestern portion of the Republic. For the cities of the plateau region from Zacatecas to Oaxaca, the records show a fairly uniform range through the year, the maxi-

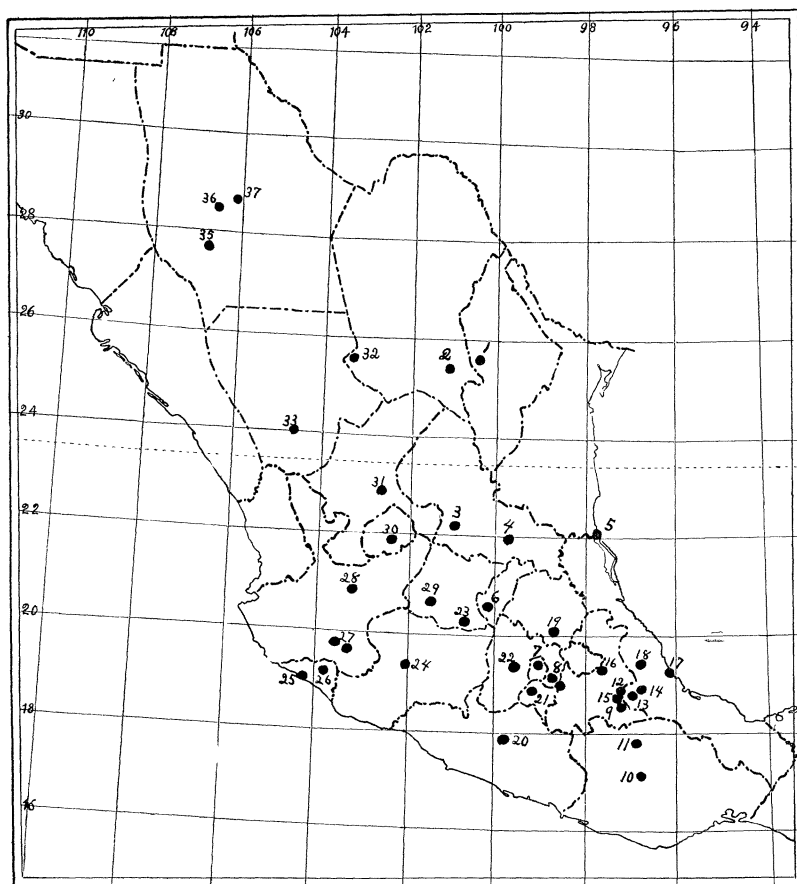
<sup>5</sup> From "The Distribution of the Rainfall over the Land," by Arthur J. Herbertson, London, 1900, an extra paper published by the Royal Geographical Society.

<sup>6</sup> *Op. cit.*, 321.



MAPS SHOWING THE ANNUAL RAINFALL BY MONTHS.

mum in May and the minimum in December and January. At Zacatecas, Mexico City and Puebla the average temperature for May is about  $18.5^{\circ}\text{C}$ . ( $65^{\circ}\text{F}$ .). The average for December and January is about  $12^{\circ}\text{C}$ . ( $54^{\circ}\text{F}$ .) for Mexico City and Puebla, and slightly lower, about  $11^{\circ}\text{C}$ . ( $52^{\circ}\text{F}$ .), for Zacatecas. At Real del Monte, a city located at a higher altitude than those mentioned, the average for May is only  $14.8^{\circ}\text{C}$ . ( $59^{\circ}\text{F}$ .) and for December only  $10^{\circ}\text{C}$ . ( $50^{\circ}\text{F}$ .). The cities of Jalapa, Mirador and Córdoba, lying along the eastern slope from the plateau and about the latitude of Mexico City, show annual fluctuations about the same as those for the plateau but the temperatures are higher. At Jalapa, with an altitude of about 4,600 feet, the average for May is  $20.4^{\circ}\text{C}$ . ( $69^{\circ}\text{F}$ .), and for December and January is  $14.5^{\circ}\text{C}$ . ( $58^{\circ}\text{F}$ .). At Mirador (3,600 ft.) and Córdoba (2,700 ft) the average for May is  $23^{\circ}\text{C}$ . ( $73^{\circ}\text{F}$ .); for January,  $16.6^{\circ}\text{C}$ . ( $62^{\circ}\text{F}$ .) for the former, and  $18^{\circ}\text{C}$ . ( $64^{\circ}\text{F}$ .) for the latter. At Veracruz, situated on the Gulf Coast, at sea level, in about the same latitude,



MAP SHOWING WHERE COLLECTIONS WERE MADE DURING THE SUMMER OF 1910. The numbers refer to the stations given in Table II. In 1908 the writer visited Guaymas and Hermosillo in the state of Sonora which lies west of Chihuahua and is the northwestern state on the map.

the average temperature is considerably higher. The five months from May to September show monthly averages of 27–27.7° C. (80–82° F.), while the comparatively cool months of December and January show averages of nearly 22° C. (71° F.). Tuxpan, a more northerly coast town, shows even higher averages, and Tampico, a coast city still further north, shows a summer temperature about the same as Veracruz but a winter temperature somewhat lower. Mérida, in Yucatán, shows a maximum average in May of 28.5° C. (83° F.) and a minimum in December of 22.4° C. (72° F.). The monthly averages for Mazatlán, on the Pacific Coast, show a gradual maximum from June to September of 27–28° C. (81–82° F.) and a minimum in January of 19.3° C. (67° F.). The temperatures increase during the dry season, reaching a maximum



A VIEW ON THE PEDREGÁL, NEAR MEXICO CITY. This is an extremely rough lava area about six miles long and three miles wide. The flora consists mainly of desert plants.



THE FLORA OF THE PEDREGÁL. The aspect of the Pedregál is similar to that of the aa or rough lava streams in the Hawaiian Islands.

just before the beginning of the rainy season which is usually in May or June.

*Itinerary.*—Investigations were made at about forty localities in nearly all the states of Mexico north of the Isthmus of Tehuantepec. The route of travel was, in general, from Laredo to the City of Mexico, returning to El Paso, with side trips to Tampico, Veracruz, Oaxaca, Balsas, Uruápan, Manzanillo, Durango and other points. The following table shows the places visited, and the numbers of the specimens collected:<sup>7</sup>

TABLE II  
LOCALITIES VISITED WHILE COLLECTING GRASSES

Locality	State	Approximate Altitude in Feet	Date	Field Numbers of the Specimens
1. Monterey....	Nuevo León ...	1,500	July 6- 9	5517-5578
2. Saltillo....	Coahuila .....	5,000	" 10-14	5579-5652
3. San Luis Potosí....	San Luis Potosí.	6,300	" 15-18	5653-5711
4. Cárdenas....	San Luis Potosí.	3,000	" 19-20	5712-5778
5. Tampico....	Tamaulipas ....	sea level	" 21	5779-5799
6. Querétaro....	Querétaro.....	6,000	" 24-26	5802-5870
7. City of Mexico and vicinity.....	Distrito Federal	7,400	" 27-Aug. 2	5871-5960
8. Popo Park and Mt. Popocatepetl. . .	México....	7,600-14,000	Aug. 3- 7	5961-6029
9. Tehuacán....	Puebla.....	5,500	" 9-10	6030-6095
10. Oaxaca....	Oaxaca.....	5,000	" 12-13	6096-6190
11. Tomellín....	Oaxaca....	2,000	" 14-15	6191-6249
12. Chalchicomula and Mt. Orizaba....	Puebla.....	9,000-14,000	" 16-22	6250-6309
13. Orizaba....	Veracruz .....	4,000	" 24-25	6310-6394
14. Córdoba.....	Veracruz....	2,700	" 26-27	6395-6462
15. Esperanza....	Puebla....	8,500	" 28	6463-6504
16. San Marcos....	Puebla....	8,500	" 29	6505-6546
17. Veracruz....	Veracruz....	sea level	" 30-Sept. 1	6547-6556
18. Jalapa....	Veracruz....	4,600	Sept. 2- 4	6587-6685
19. Pachuca....	Hidalgo....	8,000	" 6- 7	6700-6770
20. Balsas....	Guerrero....	1,500	" 9	6772-6816
21. Cuernavaca....	Morelos....	4,500	" 10-11	6817-6885
22. Toluca....	México....	8,800	" 13	6886-6921
23. Acámbaro....	Guanajuato....	6,300	" 14	6924-6954
24. Uruápan....	Michoacán....	5,600	" 16	6957-7005
25. Manzanillo....	Colima....	sea level	" 19-20	7026-7046
26. Colima....	Colima....	1,500	" 21	7054-7110
27. Zapotlán and Nevada Peak.....	Jalisco....	5,000-14,300	" 22-25	7111-7259
28. Guadalajara....	Jalisco....	6,100	" 27-29	7260-7386
29. Irapuato....	Guanajuato....	5,800	Oct. 1	7387-7438
30. Aguascalientes....	Aguascalientes....	6,300	" 2	7439-7494
31. Zacatecas....	Zacatecas.....	7,500	" 3- 4	7495-7537
32. Torreón....	Coahuila.....	3,800	" 5	7538-7564
33. Durango....	Durango....	6,200	" 6- 8	7565-7660
34. Torreón....	Coahuila....	3,800	" 9-10	7724-7729
35. Sanchez....	Chihuahua....	8,000	" 12	7661-7723
36. Miñaca....	Chihuahua....	7,000	" 13	7731-7769
37. Chihuahua....	Chihuahua....	4,600	" 14	7770-7803

<sup>7</sup> Missing numbers were collected at intermediate stations along the railroad.



MT. POPOCATEPETL NEAR THE SNOW LINE. The tracks of cattle are seen in the sandy barrens. The white spots are the remains of the snow from a recent squall.



*Epicampes macroura* ON MT. POPOCATEPETL. The roots, obtained by prying up the large tussocks, are used in the manufacture of scrubbing brush.



*Epicampes macroura*. A single small cluster along a railway embankment at San Marcos, near Puebla. The flowers are in a dense spikelike inflorescence at the ends of the stems.

Mt. POPOCATEPETL. The upper part of the mountain is bathed in clouds. At the lower edge of the cloud cap can be seen spurs descending from the snow fields. The sandy waste in the foreground is the home of *Festuca livida* a bunch grass about six inches high with large purple spikelets.

### BOTANICAL AND AGRICULTURAL OBSERVATIONS

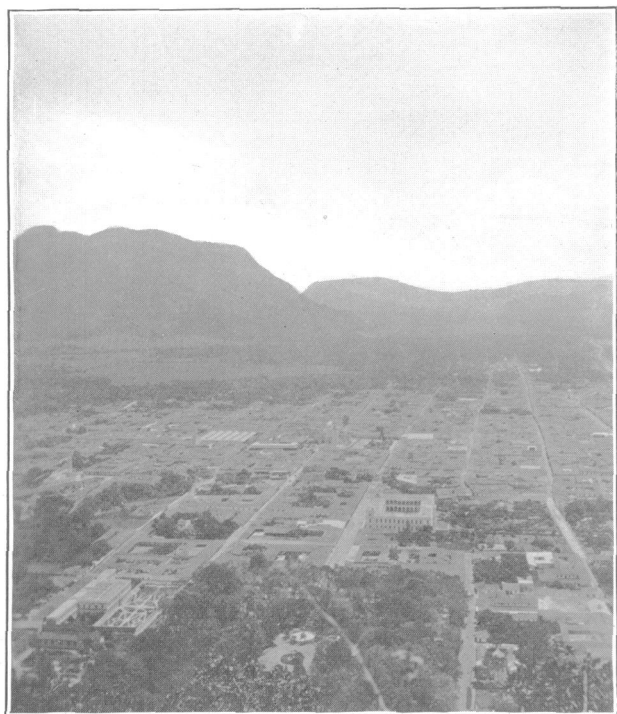
The observations here recorded are very elementary and emphasize unduly the group of plants which I was investigating, but they may be of interest because, though Mexico is our next-door neighbor, its characteristics are unfamiliar to the average scientist who has not visited the country.

*Floral Regions.*—The great central plateau is an arid region, the flora of which is similar to that of southern Arizona, New Mexico and Texas. The flora of the Great Plains extends through Texas into the northeastern Mexican states, while the desert flora of southern Arizona extends into the states of Sonora and Chihuahua. The former flora is characterized especially by grasses; the latter especially by cactuses, agaves, yuccas, and various thorny shrubs. In a more or less modified form this desert flora is found on the plateau as far south as the state of Oaxaca. The upper part of the higher mountain ranges are usually wooded, the Sierra Madre range supporting extensive areas of coniferous forest. The rainfall in the mountain areas is greater than in the adjoining plains. The hills and the more isolated mountain ranges are usually rocky sterile wastes devoid of timber.

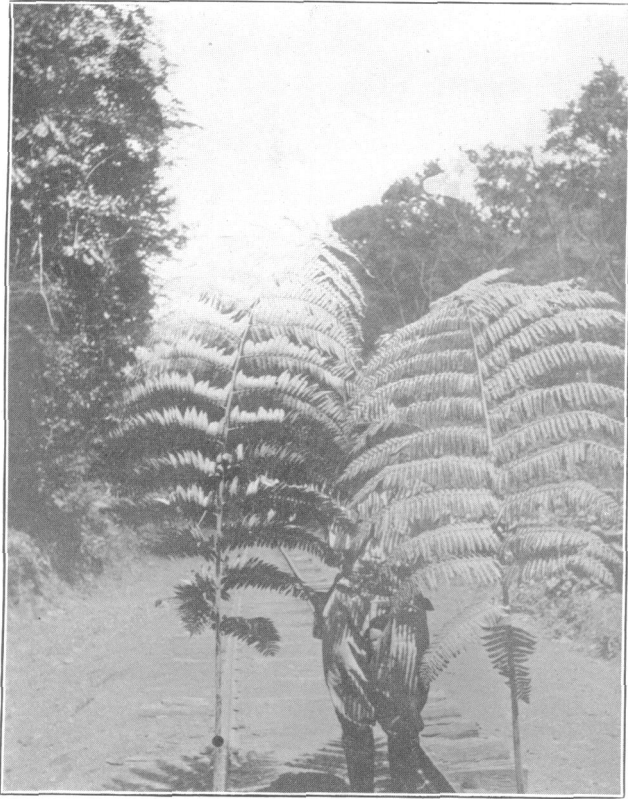
The low land along the eastern coast between the Gulf of Mexico and the foothills which mark the beginning of the as-

cent to the plateau is covered with a low forest which becomes toward the south a tropical jungle. The coastal plain of the Pacific coast is similar, but not so well marked, the hills in many places extending to the very coast. In Sonora the rainfall is not sufficient to support a forest. In all this low land, the *tierra caliente*, or hot country, the grasses are usually poorly represented both in species and individuals. At Veracruz the sandy plains immediately back of the coast are covered with an abundance of certain species of grasses, but in general such areas represent a very small proportion of the total.

The central plateau supports a desert flora, the density of which is largely dependent upon the amount and distribution of the rainfall. In the northern portion, north of the isohyet marking the limit of twenty inches annual precipitation, the grass flora is that of the desert regions of Arizona and New Mexico. The grasses are in bunches, known to stockmen as bunch-grasses, scattered over the surface of the mesas or of the lower hills. In the more arid places the bunches are at intervals of several feet, while in moist spots the bunches may be separated by only a few inches. Only under especially favorable conditions do the bunches approach one another to



ORIZABA FROM THE HILL LYING JUST TO THE WEST OF THE CITY.



TWO FERN FRONDS FROM THE TROPICAL JUNGLE AROUND JALAPA.

form a continuous mass or sod. Grasses with creeping rootstocks are not so common. In the northeastern states, where the Texas flora intrudes, may be found areas of sod formed by the buffalo-grass (*Bulbils dactyloides*), curly mesquite (*Hilaria cenchroides*) and allied species. During and shortly after the rainy season the grasses of the mesa thrive and produce their flowers and seed. Later they become dry and brown, and retain life only in the crown and underground parts. The mesa grasses belong chiefly to the large genera, *Aristida*, *Bouteloua*, *Muhlenbergia*, *Sporobolus* and *Stipa*.

The region in which the grasses occupy the most important and conspicuous place is the slope from the central plateau to the coastal plain. This slope is characterized by an extremely irregular topography, being cut by numerous deep ravines, or *barrancas*. The rainfall increases rapidly toward the coastal plain, especially along the southeastern slope in the state of Veracruz. At the higher elevations there are extensive prairies with a rank growth of grass. Many of the hillsides and

the slopes of the deep barrancas are covered with grass. As the altitude decreases the proportion of forest-covered area increases and the grassy areas are confined to the hills. In this region the grasses are more tropical, and the genera *Andropogon*, *Panicum* and *Paspalum* are well represented.

On the upper slopes of the high mountains the grasses are often conspicuous. At moderate elevations, 9,000 to 11,000 feet, the large bunches of certain species of *Festuca* and *Epicampes* may cover large areas of treeless or sparsely wooded slopes. One species, *Epicampes macroura*, is used commercially, the strong roots furnishing material for coarse brushes. At the upper elevations, near or above the timber line, are found several kinds of tussock grasses belonging to the genera *Festuca*, *Deschampsia* and *Agrostis*. Upon the alpine summits, or the alpine belt below perpetual snow of the highest peaks, occur scattered dwarf alpine grasses belonging to the three genera just mentioned, together with certain species of *Poa*, *Calamagrostis* and *Trisetum*.



A LITTLE MOTHER CARRYING HER BROTHER WHO IS HALF AS LARGE AS SHE. The picture was snapped as she was trying to escape from the dreaded camera.

In the valleys upon the plateau agriculture is carried on with the aid of irrigation. Along the irrigation ditches may be found representatives of the native flora of the region even during the dry season when the plants upon the mesa are passing through their resting stage. The collections made by the writer in the arid northern portion of the plateau were chiefly from the vicinity of irrigation ditches or irrigated fields. In cultivated soil the species of grasses occurring are mostly weedy annuals, but along the ditches or the edges of the fields



A STREET IN ORIZABA, showing the characteristic Spanish architecture.

are found portions of the original vegetation which includes many species in flower, although the mesa may be brown and sere, presenting no grasses in flower.

*Range Conditions.*—Stock-raising is an important industry throughout the plateau. The grazing conditions are similar to those of the southwestern United States. Cultivated fields on that portion of the plateau north of about  $22^{\circ}$  latitude are confined to the vicinity of the water courses of the valleys that can be reached by irrigation ditches. Outside of such areas the agriculture of the country is confined chiefly to stock raising. Cattle, sheep and goats roam over the land, living upon the scattered herbage, the grazing radius being limited by the distance to water. Though grazing animals feed on a variety of plants, there is no doubt that the grasses form the most important part of the available forage. It not infre-

quently occurs that the grass vegetation has been almost entirely removed from an area by grazing animals, the original grass flora being preserved only within the protection of clumps of cactuses or other thorny plants, or upon inaccessible rocky cliffs.

The ranges include the highest mountains, and cattle were observed feeding far above timber line upon the snow-clad peaks of Orizaba and Popocatepetl, their tracks or evidences of grazing extending to snow-line.

*Forage Crops.*—So far as observed all forage that is cut is consumed green. By far the most important forage crop is corn or maize. This plant is grown primarily for the grain but large quantities are cut green for fodder. As the crop nears maturity a portion of the foliage may be stripped or the part of the stalk above the ear may be removed for forage. Much green feed is obtained by the poorer classes by pulling up weeds from cultivated fields or by cutting rank grass or weeds along the roadsides, the railroad right of way, or any other available source.

Alfalfa is commonly grown upon the plateau, but usually in comparatively small patches. One field was observed near Toluca which consisted of more than one hundred acres, the plants being grown in rows and cultivated. Throughout much of the plateau region the crop requires irrigation during the dry season. Ordinarily the alfalfa is sown broadcast and irrigated by the check system. The field is divided into several small plots, twenty to fifty feet square, by low ridges or dikes. The crop is cut by hand with sickles or knives, often close to the surface of the ground. The green alfalfa is placed in small heaps and later tied in bundles to be loaded on burros for delivery. Some of the larger ranches or haciendas are adopting modern methods and machinery.

At low altitudes, especially in the coastal plain, are cultivated Pará-grass and Guinea-grass (pronounced in Spanish, Guinay'-a). Pará-grass (*Panicum barbinode*) is cultivated chiefly for pasture. It produces a tangle of rootstocks and stolons which soon bind the soil into a firm sod. It is propagated by planting cuttings of the creeping stems.

Guinea-grass (*Panicum maximum*) is a perennial rootstock-bearing bunch-grass, cultivated chiefly for green forage. It grows to a height of five to eight feet or even more. The grass is propagated by planting pieces of the crown, or the creeping rootstocks. When growing isolated the stems may be more or less decumbent, but under field conditions the growth is upright.